Final report, Joint Fire Science Program AFP 3 -2001

Project Title: Pre-Fire Fuel Manipulation Impacts on alien Plant Invasion of Wildland

JFSP Project No.: 01B-3-2-08

Project Location: Southern, central and northern California

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This final report details finds and accomplished deliverables. Details on the study background, objectives, methods and evidence to support these findings are presented on our updated web page (http://www.werc.usgs.gov/fire/seki/ffm/), which is one of the proposed deliverables and *Merriam, K.E., J.E. Keeley, and J.L. Beyers. 2006. Fuel breaks affect nonnative species abundance in California plant communities. Ecological Applications 16:515-527* can be downloaded from http://www.werc.usgs.gov/seki/keeley.asp. An additional large technical report is being printed and will be distributed shortly.

SUMMARY OF FINDINGS TO DATE

This study addressed the role of fuel breaks in the invasion of alien plant species into wildland areas. We investigated fuel breaks on lands managed by federal, state, and local jurisdictions throughout California. Our study had three objectives:

1) To inventory the floristic composition of fuel breaks within diverse fuel types, including shrublands, woodlands and coniferous forests, and to relate patterns of alien plant distribution to fuel break parameters, including construction and maintenance methods, fire history, and land use;
2) To intensively sample belt transects perpendicular from fuel breaks into surrounding vegetation to determine the extent to which fuel breaks may act as source populations for the invasion of wildland areas;
3) To provide resource managers with information that will allow them to plan fuel manipulations to minimize the negative impacts of nonnative invasive plants on natural landscapes.

We evaluated the abundance of nonnative plants on fuel breaks and related fuel modification projects and in adjacent wildland areas. Our study sites (Figure 1) were located across California in coastal scrub, chaparral, oak woodland, and coniferous forest vegetation types, and the fuel breaks we sampled represented a range of construction methods, maintenance regimes, and fire histories.

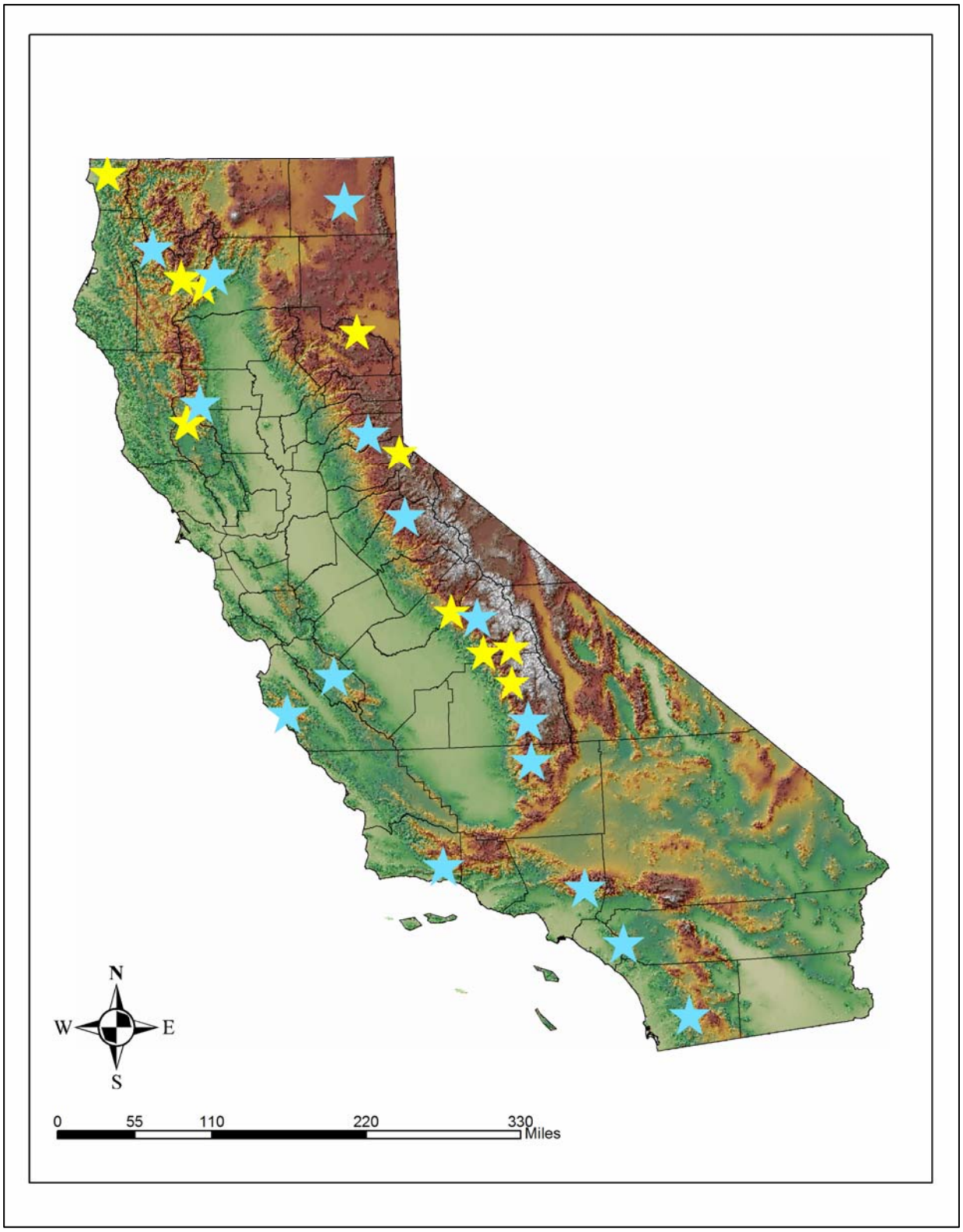

Figure 1. Sites with fuel modification projects studied in this investigation.

We found that nonnative presence, cover, density, and species richness were significantly higher on fuel breaks than in surrounding wildland areas. Different fuel break construction methods, as well as several environmental covariates, were significantly associated with variation in relative nonnative abundance. Fuel breaks constructed by bulldozers had higher relative nonnative cover, lower overstory canopy cover, and lower litter cover than fuel breaks constructed by other methods. There was a significant decline in relative nonnative cover with increasing distance from the fuel break in all vegetation types. This decline was most dramatic in areas that had experienced more numerous fires during the past fifty years. Nonnative plants were more abundant in these burned areas and in areas that had been grazed. These data suggest that fuel breaks could provide establishment sites for nonnative plants, and that nonnatives may invade surrounding areas, particularly after disturbances such as fire. Fuel break construction and maintenance methods that leave some overstory canopy and minimize exposure of bare ground may be less likely to promote nonnative plants.

Management Implications:

☛ One of the resource costs associated with fuel break and other fuel medication practices is their potential impact on alien plant invasion.

☛ The problem is greatest in lower elevation shrubland and woodland formations.

☛ Certain methods of construction and maintenance have lesser effects than others.

☛ Fuel modifications have the greatest chance of enhancing non-native plant invasions when coupled with livestock grazing.

☛ Fuel breaks in areas with repeat fires are most likely to contribute to non-native plant invasion of untreated areas.

DELIVERABLES

Proposed : **Scientific publications**

Status:

Several completed and planned projects detail the role of fuel breaks on alien plant invasion and investigate how different construction and maintenance methods affect the invasion process.

Merriam, K.E., J.E. Keeley, and J.L. Beyers. 2006. Fuel breaks affect nonnative species abundance in California plant communities. ***Ecological Applications*** *16:515-527.*

Posted at http://www.werc.usgs.gov/seki/keeley.asp.

Merriam, K.E., J.E. Keeley and J.L. Beyers. The effect of fuel reduction treatments on plant diversity. In preparation.

This work has also led to various reviews that have attempted to extend our findings to other fire management practices.

Keeley, J.E. 2006. Fire management impacts on invasive plant species in the western United States. ***Conservation Biology*** *20:375-384.* Posted at http://www.werc.usgs.gov/seki/keeley.asp.

Keeley, J.E. 2005. Fire management impacts on invasive species at the wildland/urban Interface in California. Pages 71-75 in C. Priosko, editor. Proceedings California Invasive Plant Council Symposium, Volume 8. California Invasive Plant Council, Berkeley, California. Posted at http://www.werc.usgs.gov/seki/keeley.asp.

Merriam, K.E., T.W. McGinnis and J.E. Keeley. 2004. The role of fire and fire management in the invasion of nonnative plants. ***Park Science*** *22(2):32-36,52.* Posted at http://www.werc.usgs.gov/seki/keeley.asp.

Brooks, M.L., C.M. D'Antonio, D.M. Richardson, J.M. DiTomaso, J.B. Grace, R.J. Hobbs, J.E. Keeley, M. Pellant, D. Pyke. 2004. Effects of invasive alien plants on fire regimes. ***Bioscience*** *54:677-688.* Posted at http://www.werc.usgs.gov/seki/keeley.asp.

Keeley, J.E. 2004. Invasive plants and fire management in California Mediterranean-climate ecosystems. In M. Arianoutsou (ed) ***10th MEDECOS – International Conference on Ecology, Conservation and Management****, Rhodes Island, Greece.* Posted at http://www.werc.usgs.gov/seki/keeley.asp.

Before beginning our field studies we decided it would be valuable to contrast different sampling techniques and the results of this comparison were published as follows:

Keeley, J.E. and C.J. Fotheringham. 2005. Plot shape effects on plant species diversity measurements. ***Journal of Vegetation Science*** *16:249-256.* Posted at http://www.werc.usgs.gov/seki/keeley.asp.

A related issue that we also investigated on some of our sites was how postfire rehabilitation affected the alien invasion process, which led to these papers:

Keeley, J.E., C.D. Allen, J. Betancourt, G.W. Chong, C.J. Fotheringham, and H.D. Safford. 2006. A 21st century perspective on postfire seeding. ***Journal of Forestry*** *104:103-104.* Posted at http://www.werc.usgs.gov/seki/keeley.asp.

Keeley, J.E. 2004. Ecological impacts of wheat seeding after a Sierra Nevada wildfire. ***International Journal of Wildland Fire*** *13:73-78.* Posted at http://www.werc.usgs.gov/seki/keeley.asp.

Proposed : **Press Release explaining results to managers**

Status:

http://www.werc.usgs.gov/pubbriefs/Keeleypbapr2006.html

http://www.werc.usgs.gov/pubbriefs/Keeleypbapr2006b.html

http://www.werc.usgs.gov/pubbriefs/keeleypbmay2005.html

http://www.werc.usgs.gov/pubbriefs/brookspbjul2004.html

http://www.werc.usgs.gov/pubbriefs/keeleypbapr2004a.html

Proposed : **Results will be presented at regional and national scientific meetings**

Status:

Keeley, J.E. 2005. Impact of Fire History on Alien Plant Invasion Following Fire in Mediterranean-Climate Shrublands of California. Ecological Society of America Annual Meeting, Montreal, August, 2005.

Merriam, K.E., J. E. Keeley, and J.L. Beyers. 2004. The Effect of Pre-Fire Fuel Manipulations on Alien Plant Invasion. California Invasive Plant Council Annual Meeting, Ventura, CA, October, 2004 *http://www.werc.usgs.gov/fire/seki/ffm/pdfs/CALIPC_abstract.pdf*

Merriam, K.E., J. E. Keeley, and J.L. Beyers. 2004. The Effect of Pre-Fire Fuel Manipulations on Alien Plant Invasion. Ecological Society of America Annual Meeting, Portland, OR, August 2004. *http://www.werc.usgs.gov/fire/seki/ffm/pdfs/esa_abstract_04.pdf*

Keeley, J.E. 2004. Plot Shape Effects on Measurements of Plant Diversity. International Association of Vegetation Science Annual Meeting, Kona, Hawaii, 2004

McGinnis, T.W., K.E. Merriam, and J.E. Keeley. Cheatgrass invasion in treated ponderosa pine forests of the Sierra Nevada. 7th Intern. Conf. On the Ecology and Management of Alien Plant Invasions, Ft. Lauderdale, FL, October 2003

Merriam, K.E., J. E. Keeley, and J.L. Beyers. 2003. The Effect of Fuel Treatments on the Invasion of Nonnative Plants. Invasive Plants in Natural and Managed Systems: Linking Science and Management, Fort Lauderdale, FL, November 2003.

Merriam, K.E., J.E. Keeley, and J.L. Beyers. 2002. Pre-Fire Fuel Manipulation Impacts on Alien Plant Invasion of Wildlands. Sierra Nevada Science Symposium, Lake Tahoe, California, October 2002. *http://danr.ucop.edu/wrc/snssweb/post_fire.html#keeley2*

Proposed : **Final Report**

Status:

Delivered 1 December 2005, revised 18 May 2006.

Proposed : **Technical Report (detailed results and suggested mitigation measures)**

Status:

Merriam, K.E., J.E. Keeley, and J.L. Beyers. 2006. The role of fuel breaks in the invasion of nonnative plants. USGS Open-File Report. In press.

Proposed : **Web Page**

Status:

http://www.werc.usgs.gov/fire/seki/ffm/ (updated Winter 2006)

Proposed : **Workshops**

Status:

We replaced these workshops with one on one discussions with forest botanists at the following:

- Angeles National Forest
- Bureau of Land Management, Bakersfield Office

- California Department of Forestry and Fire Protection, San Luis Obispo Unit
- Cleveland National Forest
- Lassen National Forest
- Los Angeles County Fire Department, Forestry Division
- Los Padres National Forest
- Mendocino National Forest
- Orange County, Harbors, Beaches and Parks Division, Casper's Wilderness Park
- Plumas National Forest
- San Bernadino National Forest
- Santa Monica Mountains National Recreation Area
- Sequoia National Forest
- Sierra National Forest
- Six Rivers National Forest
- Shasta-Trinity National Forest
- Sequoia and Kings Canyon National Park
- Whiskeytown National Recreation Area

In addition, the following reports were submitted to some of the agencies involved in this work:

Merriam, K.E. and J.E. Keeley. 2003. Pre-Fire Fuel Manipulation Impacts on Alien Plant Invasion of Wildlands. Investigators Annual Report submitted to Sequoia and Kings Canyon National Park.
Link at http://www.werc.usgs.gov/fire/seki/ffm/

Merriam, K.E. and J.E. Keeley. 2002. Pre-Fire Fuel Manipulation Impacts on Alien Plant Invasion of Wildlands. Investigators Annual Report submitted to Sequoia and Kings Canyon National Park.
Link at http://www.werc.usgs.gov/fire/seki/ffm/

Merriam, K.E. and J.E. Keeley. 2002. Pre-Fire Fuel Manipulation Impacts on Alien Plant Invasion of Wildlands. Investigators Annual Report submitted to Whiskeytown National Recreation Area. Link at
http://www.werc.usgs.gov/fire/seki/ffm/

In addition the following outreach talks were given:

Merriam, K.E., J. E. Keeley, and J.L. Beyers. 2005. Pre-Fire Fuel Manipulation Impacts on Alien Plant Invasion of Wildlands. USDA Forest Service Botanist Meeting, Ventura, California, March 3, 2005.

Merriam, K.E., J. E. Keeley, and J.L. Beyers. 2005. Pre-Fire Fuel Manipulation Impacts on Alien Plant Invasion of Wildlands. USDA Forest Service Ecologists Meeting, Davis, California, March 15, 2005.

Keeley, J.E. 2004. Invasive plants and fire management in California Mediterranean-climate ecosystems. In M. Arianoutsou (ed) 10th MEDECOS – International Conference on Ecology, Conservation and Management, Rhodes Island, Greece.

Merriam, K.E. 2004. Pre-Fire Fuel Manipulation Impacts on Alien Plant Invasion of Wildlands. Presentation of results to Sequoia National Park, Ash Mountain Conference Room, May 27, 2004.

Merriam, K.E. 2003. Invasive Plants and Fuel Breaks in the Sierra Nevada. Presentation of preliminary results to California Native Plant Society, Fresno, California, September 16, 2003.

Merriam, K.E. 2003. The Effect of Fuel Treatments on Alien Plant Invasion. Presentation of general research design and methods to USGS seasonal employees, Ash Mountain Conference Room, May 20, 2003.

Merriam, K.E. 2003. Pre-Fire Fuel Manipulation Impacts on Alien Plant Invasion of Wildlands. Presentation of preliminary results to Sequoia National Park, Ash Mountain Conference Room, February 19, 2003.